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Contingency Planning with Aerial Photography and Geographic Information Systems

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16. ABSTRACT

The incident at the 3 Mile Island Nuclear Plant has led to many changes in the operation and employee training in U.S. Nuclear Power Industry. To date, few if any changes have been made to emergency plan preparation and the establishment of a geographic information system for each operational plant.

This paper presents an approach to the preparation of a comprehensive geographic information system that would meet the needs for monitoring, movement of population away from a site and general information for decision making.

The geographic system would cover each of the 72 plants now in operation and the approximately 94 sites under construction. Each site would have a portfolio prepared to show:

- a high altitude aerial photo and selected low level photos
- inventory of drinking water locations
- an inventory of dairy farms
- a population distribution plot
- an inventory of food crop-producing farms
- general land-use to a USGS level III/IV
- meteorological data
- routes of egress and access, and
- a topographic map with potential monitoring sites.

The paper proposes how to use aerial photography, topographic maps and meterological data to prepare the emergency documents. Cost of acquisition, analysis and documentation are presented.

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INTRODUCTION

On Wednesday March 28, 1979 at 36 seconds after 4 am a pump tripped at the nuclear powerplant at Three Mile Island, Middletown Pennsylvania. As the Government Accounting Office stated: "Thus began the most studied accident in history". The report goes on to state that "no one was adequately prepared for a nuclear accident."

The liteny of problems in emergency planning are endless. The President's Commission found a history of low priorities at Federal, State and local levels. The Governor of Pennsylvania decried the lack of reliable decision making information in the areas which would possibly be affected by the release of nuclear radiation.

Four years have passed and many changes in plant operation have been made by the power industry and by the Federal government. Yet in March of 1983 there was a flap in the press about how a nuclear power plant might be closed because the surrounding communities were refusing to cooperate with the plant operators and prepare contingency plans. It was not until June that the NRC decided that the lack of a plan would not cause the plant to cease operation.

CURRENT PLANNING GUIDANCE

The Federal program to establish contingency planning at and around power plants is in fact under regulation and an active program. The Federal Emergency Management Agency (FEMA) in 1980 promulgated regulations for the preparation of emergency preparedness plans for commercial nuclear power plant accidents. They then followed up in 1983 with an exhaustive document on "Planning Guidance for the Preparation of the Federal Radiological Emergency Response Plan (FRERP)."

In the opening sentance the document states "the success of the Federal response to a peacetime radiological emergency such as an incident at a nuclear power plant, depends on adequate advance planning and preparation." One basic premise must be followed in the preparation of the plans. "During an emergency the owner and operator of the affected facility is responsible for minimizing the radiological hazardous to the public. State and local governments have the primary responsibility for implementing measures off-site to protect the public, property and the environment. "All Federal Agency response plans should recognize the primancy of the response roles of owners and operators and State and local agencies."

According to the plan there are sixteen Federal Departments and Agencies directly involved in planning and executing support in the event of an emergency. Each Agency plans its own program and determines the feasibility of the assigned tasks. The FEMA acts as a point of coordination to assess whether "stated responsibilities and appropriate interfaces have been addressed." The Department of Energy then takes the lead in coordinating and issuing the plan.

There still appears to be a gap involved in the preparation of the federal plans. Throughout all the documents that access the Three Mile Island Accident, one common thread can be found. All the Agencies, State and local communities, did not have a common data base upon which to base their decisions. The Federal program still does not address this problem. This paper presents an EPA Office of Research and Development (ORD) approach to preparing a supplemental program to the FRERP. The preparation a series of folios of environmental data for each of the 55 geographic sites of nuclear power generation would be presented on such a common base. The data presented would not only be prepared in "hard copy" format but would be made available to the Agencies and States in digital form that could then be manipulated to meet individual organizational needs. As changes and expansion in the base occur the digital data would be interchanged and new and updated documents could be prepared.

APPROACH

The EPA/ORD approach is to prepare a series of geographic information data bases on each of the 55 sites in The United States. As shown in Figure 1, fourty-eight of the sites are located east of the Mississippi River. Further, because several sites are in close proximity to each other, the number of folios to be prepared come to fifty two. Appendix I provides a list of the plants shown in Figure 1.

Each folio would provide the 16 Federal Agencies with a common base from which to make decisions. These decisions are important to the mission each organization. They also directly impact the decisious made by the other Federal State and local participants. Thus it is imperative that each organization begin at a common point. Each folio will contain several aerial photos of the power plant, urban areas within 10 miles and examples of the terrain and land use surrounding the plant. Figure 1 illustrates a typical photo that will be enclosed.

The base for the folio will be a series of topographic maps produced by the U.S. Geological Survey. The first map at a scale of 1:250,000 will locate the plant, indicate the urban areas within five, ten and 20 mile radios and provide an index for 1:24,000 scale maps. The 1:24,000 maps will provide the detailed data on terrain, transportation and land cover.

The data for the production of this product will be derived from a number of sources in the Federal Government. Land use maps prepared at the second level and aerial photography will be obtained from the U.S. Geological Survey. Weather data, population and vehicle data obtained from the Department of Commerce will also be incorporated. State and

Figure 1 Low oblique photograph of the Three Mile Island Power Plant. Photo obtain with the Enviro-pod at approximately 1500 feet above the site.

local agencies will also be expected to contribute to the location of key facilities such as police stations, health laboratories and senior citizen residences.

The collation of the data and the analysis of aerial photography will be performed by the Environmental Protection Agency's Image Analysis System. This system will also be used to produce the digital products and overlays for the folios. Supplementary photographic data will be provided by the EPA Enviro-pod.

A more detailed discussion of the sources of data and their application to the final product follows:

Land Use

The Geological Survey is compiling land use and land cover map series and for the entire United States. Land use refers to man's activities while land cover describes the vegetation, water, and sand on the land surface. These maps provide a consistent level of detail, standardization of categories, and appropriate use of scales of compliation for land use planners, land managers and resource management planners. These maps and data have been used for river basin planning, analysis of land use and land cover change on barrier islands in relation to recreational and other uses, river quality assessments, preparation of environmental impact statements, study of onshore impacts of offshore oil development and studies of urbanization.

The land use series are being compiled using the Anderson classification system that is composed of nine general Level 1 categories that are further subdivided into 37 more specifically defined Level 11 categories.

A mapping unit having a minimum size of 10 acres (4 hectares) is the smallest area mapped for all urban areas and bodies of water. It is also the minimum area mapped for surface mines, quarries, gravel pits, and certain agricultural areas. A minimum mapping unit of 40 acres (16 hectares) is used for all other categories. These minimum mapping units are the smallest areas appropriate for use on maps of 1:250,000 and 1:100,000 scales. Thus, a residential area less than 10 acres is not shown. Likewise, an area of cropland and pasture less than 40 acres is not be delineated.

Aerial photographs and other remotely sensed data serve as the primary sources used in compiling the maps. Secondary sources include earlier land use maps and other maps prepared by field-survey methods. Such maps are generally available at larger scales and for small areas such as parts of metropolitan regions.

To date, thirty nine of the fourty-five nuclear power plant sites in the Eastern U.S. are covered by the U.S.G.S. map series. Thus very little effort will be required to compile second level land use for the remaining six sites. In addition to the land use already prepared, third level land use will be prepared to depict urban and built-up areas, surface hydiological features, road networks and special activities such as industrial sites, utilities, institutional/ governmental and water uses. Appendix II provides the basic land use scheme that is used.

A special coding will be provided to estimate peak population distribution during day-time and night-time hours for all categories involved in third level urban land use. The special population analysis will also be applied for farmsteads and related buildings.

The special land use overlay will include analysis of the highway networks to include designation of the number lanes, median strips, road width and shoulders width. These designations will be made for all major highways as well as secondary roads.

High Altitude Photography

The primary source of information for the Folio Program is aerial photography provided by the Federal High Altitude Photography Program.

Aerial photography of the United States has been acquired regularly since 1932. Generally the scale of the imagery ranges from 1:5000 to 1:24,000. The early pre-50's photography is on a black and white emulsion. Since the 1960's color and color infrared have become more common. Improvements in aircraft and remote sensing technology have made it economically possible to now acquire black and white and infrared color photographs from 40,000 feet above the terrain being photographed.

In 1978 the Federal Agencies that had an interest in such data formed the National High Altitude Photography (HAP) Program. The Program, coordinated by the U.S. Geological Survey, was designed to pool federal resources and fund a private industry contract to acquire photography on a five year cycle.

By 1982 the acquired coverage totals more than 59 percent of the continental United States or over 1.7 million square miles see Figure 3 for coverage. Complete coverage is expected by 1986 when a new cycle program will begin.

Photographs from the program consist of 9 X 9 inch black and white panchromatic and color infrared film. The black and white film has a contact scale of 1:80,000. The color infrared film has a contact scale of 1:58,000.

Of the 48 nuclear power plant sites located east of the Mississippi River, thirty eight are covered by photography from the HAP. Other sources such as the data from NASA flights provides coverage of the remaining sites. The majority of sites are covered with imagery obtained after 1979, only five sites have coverage dating from 1976.

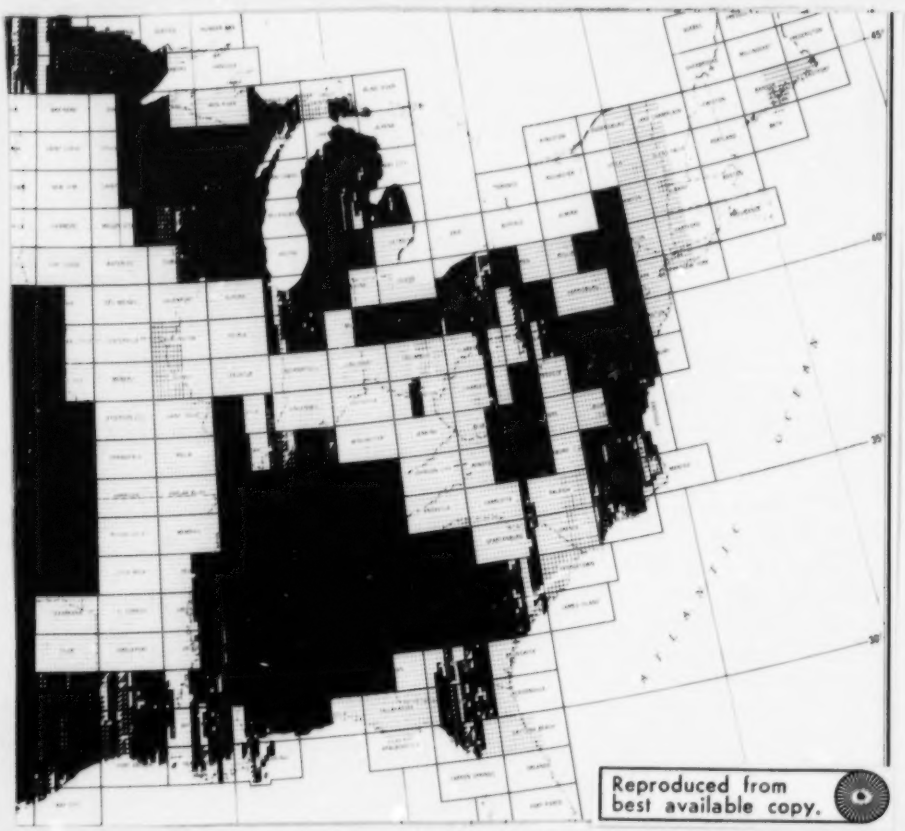

Figure 2 Status map of the National High Altitude Photography Program.

Figure 3 is an example of the resolution that can be obtained from high altitude photography. The film, acquired by the NASA U-2, can be used to produce fourth level land use and can be enlarged 20 times with little loss of ground resolution. With photography of this quality it is possible to complete all requirements for land use up-dating, identifying dairy farms and determining transportation networks and establishing, in conjunction with topographic maps and weather data, potential monitoring sites. Further, the data can be used in conjunction with census data to estimate population, locate industrial concentrations and estimate population distribution during various periods of the day.

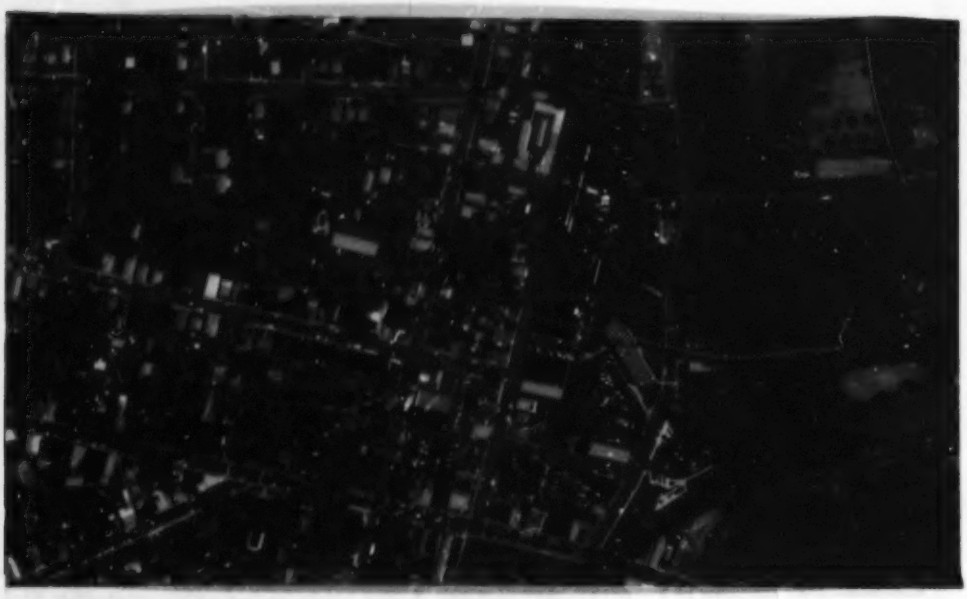

Figure 3 High Altitude Photograph of Pennsylvania. Swatara Creek is located on right of Photo. The Commercial Center of Middetown is in lower center of photo.

Enviro-Pod

No matter how competent the analyst or how well a photo interpretation is done there is always a desire to obtain more data or to up-date information. The ideal instrument to meet these needs is the Enviropod. The system, developed in 1976 by the EPA, was designed to provide the environmental scientist with an economical, compact, portable and simple to operate tool.

The design criteria established were:

- o fit a commonly available aircraft such as a Cessna 172 or 182
- o be easily installed without modification to the aircraft
- o be transportable as checked baggage aboard commercial airlines
- o be fully FAA certified for all models of the Cessna 182 and 172
- o be adaptable to more than one sensor
- o provide high resolution data that could be analyzed by the environmental scientist as well as the photo analyst.

The pod consists of two mated sections carried as an integral unit. The two sections each contain a KA-85A panoranic camera. The camera in the forward section is oriented to photograph at nadir (vertical), while the one in the aft section is oriented 45 degrees forward of nadir.

The assembled Pod is attached to the aircraft with four stainless steel straps anchored to the seat rails with a clamp mechanism. The straps are fitted with turnbuckles which attach to heavy brackets bolted to the Pod. The flexible straps are contoured to fit over the door sill so that interference with door closure is negligible. Also, the underside of each strap is lined to prevent scratching of the aircraft.

A camera control box located in the aircraft cabin is wired into the Pod electrical system through a four-strand ribbon wire located in the aircraft cockpit. The control box allows the operation of the cameras either separately or simultaneously. Cycling can be accomplished by manual control or a pre-set counter. A frame counter, ready light, cycling light, and individual camera on/off switches are also included.

The Enviro-pod cameras can acquire color, color-infrared and black and white photos. Figure 4, illustrates the maximum resolving capacitity of the black and white film acquired at an altitude of 1500 above the ground. Figure 1 is also an Enviro-pod photograph.

The typical Enviro-pod mission is generally centered less than 100-200 miles from a Regional EPA Office; The area to be covered must be relatively small in that only 300 frames of imagery are available in the cameras. Table 1 shows an example of a typical emission to acquire data on hazardous waste sites. A total of eight sites are to be covered at a scale of 1:4,000 with color imagery. The prices shown in the table include one original and duplicate print and processing.

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Figure 4 Contact 70mm x 7 inches print of Enviro-pod imagery and a 40 x enlargement of a segment.

Table 1 Enviro-pod/Conventional Aircraft Data Acquistion Cost Comparison

Enviro-pod		Conventional	
Aircraft Cessna 172 @ $67 hr		Aircraft cost $300/hr	
Flight time 7 hours	$469.00	4 hour mission	- $12.00
70 MM Color per frame	$1.04	9" color imagery per frame	- $ 4.30
8 frames/per site -	$66.56		
Total Mission	$535.36	5 frames per site	- $21.50
Total savings	$833.64	Total mission	- $1369.20

Total Savings for Enviro-pod $833.64

In an effort to automate normal imagery interpretation functions the EPA has developed an automated system that enables the photo interpreter to extract information from an aerial image of uniform and non-uniform scale, convert the data into geographic or Universal Transverse Mercator (UTM) grid coordinates and present the data on camera-ready overlays to topographic maps of any scale or as a digital data tape to be utilized in a geographic information system.

The Image Analysis System, IAS, integrates a standard interactive graphics system with Calma CGI software and Richards MIM-1540 light table modified with a digitizing grid. Data are extracted directly from the imagery and input through either the digitizer or an alphanumeric keyboard on the operator console. This console has a graphics CRT terminal to display data and an alphanumeric screen to verify coordinates and control memonics. The data are processed through a minicomputer, compared with a previously entered map base, and converted to geographic or UTM coordinates. The operator console facilitates comprehensive editing and updating. Data is stored on magnetic tapes after hard copy plots are made.

The EPA was well aware of the many advances being made in computer graphics and computer - aided mapping. Since the tried and true method of the photo analyst transferring data from the photo to map by manual interpolation was proving time consuming and labor intensive, the ORD initiated an engineering study to determine how the process could be accelerated without taking the photo analyst out of the decision making process.

As a result of the engineering study the ORD decided on a system that was made up of commercially available hardware and software. A major consideration of the study was that production be increased without commensurate labor increases. As a result of the study the following equipment was purchased:

- o Eclipse S230 minicomputer with 48K core memory
- o 80 mb disc drive
- o 9 track 800 BPI tape drive
- o Standard Calma interactive graphics station (Bacxlit Constrained Cursor digitizer work station)
- o Modified Richards Mim-1540 light table with dual CRT work station
- o Xynetics flatbed plotter
- o Calma CGI software

According to Crook and Howard the "the system operates on Calma's CGI software, which allows the operator to build, maintain, and manage a hierarchical cartographic data base, compute line lengths and areas, capture related and independent alphanumeric data, annotate and edit graphic data, and produce camera-ready hard copy output and magnetic tape files.

Crook and Howard continue, "The system is designed for rapid entry, verification and editing of cartographic data. The required numeric precision was achieved by utilizing a 64-bit floating point representation. This permits the storage of coordinates to at least 13-digit accuracy. Space was also provided in the data structure for the storage of multi-axis (x, y, and z) coordinates.

The unique tree structure of the CGI data base permits design and definition of data bases to suit particular applications. Therefore, each installation (and even each job) may have its own unique data base structure that permits full classification, storage and retrieval of the grapic and nongraphic data, as desired."

The IAS was also designed to provide a means of correlating nongraphic data to the graphic data base, thus permitting access to graphic items and related nongraphic information. The CGI information block concept to a full map) to carry descriptive text and related numeric values.

To date, the system has met all design objectives. In one particular program, the measurement of railroad noise emission sources, the EPA was required to provide data on: (1) delineation and dimensions of each railyard and its component parts (receiving, switching, and departure yards), (2) location of noise sources (switch and line engines, retarders, car and engine repair facilities, and bulk loading facilities) and distance to yard boundary, (3) a land use inventory (agricultural, residential, commercial, and undeveloped) within an area extending 2000 feet from the outer boundary of the yard (with percentage of each category that abutted the yard boundary) and distance from yard boundary to nearest residential cluster.

Although these measurements increased the workload by 75%, the IAS, while providing a higher degree of accuracy, permitted adherence to a rigid time schedule with no increase in manhours and without requiring costly overtime.

Most recently the IAS was used in a land-use study of a drainage basin around a lake. The study area was 1330 square miles. Fourty 7 1/2 minute topographic maps covered 33 sub-water sheds in the basin. A total of 19 land use categories were delinerated, 8 to the third level 10 to the second level and one at the first level.

The categories of land use were digitized and measured on the IAS. The area of the drainage basin, area of sub-basins, % of sub basin to the total, acres of land use by level, % of land use by sub-water shed and % of total basin were measured and tabulated. In addition, non-point pollution sources were identified and measured and tabulations prepared for each.

Imagery of the basin was delivered to EPA on March 23, 1983, a new data package was prepared in June 1982 and a final product 90 pages long with text was delivered in August 1982. It is estimated that without the use of the IAS the products would not be delivered for another year. The use of the IAS thus saved the ORD more than 18 work months of effort and countless thousands of dollars.

FINAL PRODUCT

The environmental data folios for nuclear power plants are to be delivered to the user community of 16 Federal Agencies, State and local communities in two formats: hard copy folio and digital tape. The hard copy will consist of a base map at a scale of 1:250;000 that provides an overview of the area. The map will outline the site and highlight urban areas within 20 miles of the plant. It will also provide a base for an index to 7.5 minute topographic maps.

The second base will be the 7.5 minute, 1:24,000 topographic sheets covering an area 10 miles from the plant. Each base map will be overlain by three overlays. The first will show a series of radii eminating from the site.

The lines will be placed at 0° North, 22.5° N 45° NE and so on around the plant. Five and ten mile circles will also be marked off. This overlay when used in conjunction with the base maps will provide all organizations with a common point of reference and sixteen pie shaped areas which can be used for planning and operation should an incident occur.

The second overlay will depict at least six types of land use ranging from single family homes to light and heavy industrial plants. Each area will also show day-time and night-time population density. The third overlay highlights the transportation network of within 10 miles of the power plant and locates all critical landuse. The overlay will locate sites such as schools, nursing homes, hospitals and correctional facilities. In addition, proposed monitoring sites for air and water monitoring will be selected and located. Consideration of prevailing winds, seasons, terrain and population location will be considered in the selection of these stations.

The second product will be a digital package that contains the data contained in land use and grid overlays. This package will, hopefully, be compatible with the existing data processing equipment of the user community and will there by available for manipulation, edit and updating with graphics equipment and computers. By storing the data digitally it will be possible to perform periodic up-dates, analyize scenarios for evaluation and determine data gaps.

The cost of production of each folio is minimal. By starting with existing USGS land use, analyzing existing high altitude photography and acquiring new low level data with the Enviro-pod, the ORD estimates that each folio will cost 15 - $18,000. This cost is an average cost. It is anticipated that plant sites such as Shoreham, located a few miles north of New York City will require an intensive land use study. Thus causing an increase in cost. However, sites such as Russelville in Arkansas and Browns Ferry in Alabama will require considerably less analysis and thus costs will be significantly less.

SUMMARY

This product is being prepared to provide Federal, State and local communities with a common base from which to plan in the event of an incident at nuclear power plants around the United States. The product was designed by the EPA/ORD to meet the needs of the EPA monitoring requirements.

Much of the data presented and the format of the products is based on the actual monitoring requirements of the Three Mile Island Monitoring Program. Discussion with other Federal Agencies including the Department of Energy and the Nuclear Regulatory Agency have been considered in the current presentation and format.

REFERENCES

Comptroller General, 1980, Three Mile Island: The Most Studied Nuclear Accident in History, EMD-80-109, September 9, 1980.

Environmental Protection Agency, 1980, Long-Term Environmental Radiation Surveillance Plan for Three Mile Island, Office of Research and Development, March 17, 1980.

Federal Emergency Management Agency, 1980 National Radiological Emergency Preparedness Response Plan for Commercial Nuclear Power Plant Accidents, Federal Register, December 23, 1980.

_____, 1983, Planning Guidance for the Preparation of the Federal Radiological Emergency Response Plan, April, 1983

Presidents Commission, 1979, The Need for Change: The Legacy of TMI, October, 1979.

U.S. Geological Survey, 1982, Index to Land Use and Land Cover Information, October 1, 1982.

_____ 1983, Status Report of the National High Altitude Photography Program, May 1, 1983.

Wray, James, R., 1982, Potential Role of Land Use and Land Cover Information in Power Plant Siting: Example of Three Mile Island, American Society of Photogrammetry, April, 1982.

Appendix I
Nuclear Power Generation Sites

Site Number	Name	Latitude	Longitude	7.5-Quad
1	Arkansas	35 18 36	93 13 51	Russelville West, Ark.
2	Beaver Valley	40 37 19	80 26 2	Hookstown, Pa.
3	Big Rock Point	45 21 33	85 11 41	Bayshore, Mich.
4	Browns Ferry	34 42 15	87 7 7	Jones Crossroad, Ala.
5	Brunswick	33 57 30	78 0 38	Southport, N.C.
6	Calvert Cliffs	38 26 5	76 26 31	Cove Point, Md.
7	D.C. Cook	41 58 34	86 33 59	Bridgeman, Mich.
9	Crystal River	28 57 26	82 41 56	Red Level, Fla.
10	Davis-Besse	41 35 50	83 5 11	LaCarne, Ohio
12	Dresden	41 23 23	88 16 16	Minooka, Ill.
13	Duane Arnold	42 6 2	91 46 38	Shellsburg, Iowa
14	Farley	31 13 22	85 6 45	Gordon, Ala. - Ga.
15	Fitzpatrick	43 31 26	76 23 54	West of Texas, N.Y.
18	Ginna	43 16 40	77 18 32	Furnaceville, N.Y.
19	Haddam Neck	41 28 55	72 29 57	Deep River, Conn.
20	Hatch	31 56 3	82 20 40	Baxley, NE, Ga.
21	Indian Point	41 16 17	73 57 9	Peekskill, N.Y.
22	Kewaunee	44 20 35	87 32 10	Kewaunee, Wis. (15 minute)
23	Lacrosse	43 33 30	91 13 50	Stoddard, Wis.-Minn.-Iowa
24	Lasalle	41 14 38	88 40 15	Odell, Ill. (15')
25	Maine Yankee	43 57 2	69 41 46	Westport, Maine
26	McGuire	35 25 56	80 56 54	Lake Norman South, N.C.
27	Millstone	41 18 31	72 10 5	Niantic, Conn.
28	Monticello	45 20 0	93 50 54	Monticello, Minn.
29	Nine Mile Point	43 31 20	76 24 36	West of Texas, N.Y.
30	North Anna	38 3 39	77 47 26	Lake Anna, West, Va.
31	Oconee	34 47 30	82 53 55	Old Pickens, S.C.
32	Oyster Creek	39 48 51	74 12 23	Forked River, N.J.
33	Palisades	42 19 20	86 18 55	South Haven, Mich. (15')
34	Peach Bottom	39 45 32	76 16 9	Holtwood, Pa.
35	Pilgrim	41 50 40	70 34 46	Manomet, Mass.
36	Point Beach	44 16 51	87 32 10	Kewaunee, Wis. (15')
37	Prairie Island	44 37 19	92 37 59	Welch, Minn.
38	Quad Cities	41 43 34	90 18 36	Cordova, Ill. - Iowa
40	Robinson	34 24 9	80 9 31	Lake Robinson, S.C.
41	Salem	39 27 46	75 32 9	Taylors Bridge, Del.-N.J.
42	Hope Creek	39 28 4	75 32 17	Taylors Bridge, Del.-N.J.
44	St. Lucie	27 20 55	80 14 47	Eden, Fla.
45	Sequoyah	35 13 24	85 5 16	Snow Hill, Tenn.
46	Summer	34 17 45	81 19 13	Jenkinsville, S.C.
47	Surry	37 9 56	76 41 54	Hog Island, Va.
48	TMI	40 9 11	76 43 30	Middletown, Pa.
50	Turkey Point	25 26 6	80 19 53	Arsenicker Keys, Fla.
51	Vermont Yankee	42 46 49	72 30 57	Brattleboro, Vt.-N.H. 15'
52	Yankee Rowe	42 43 41	72 55 44	Rowe, Mass. - Vt.
53	Zimmer	38 51 57	84 13 44	Moscow, Ohio - Ky.
54	Zion	42 26 44	87 48 8	Zion, Ill. - Wis.
55	Shoreham	40 57 30	72 52 00	Wading River, N.Y.